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(54) **DEVICE, SYSTEM, AND METHOD OF
DISPLAY CALIBRATION**

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G09G 3/20 (2006.01)
G06F 1/16 (2006.01)
G09G 3/34 (2006.01)

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(2013.01); **G06F 1/1616** (2013.01); **G09G**
3/3413 (2013.01); **G09G 5/00** (2013.01); **G09G**
2320/041 (2013.01); **G09G 2320/0693**
(2013.01); **G09G 2360/144** (2013.01)

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361/679.27; 455/575.3

See application file for complete search history.

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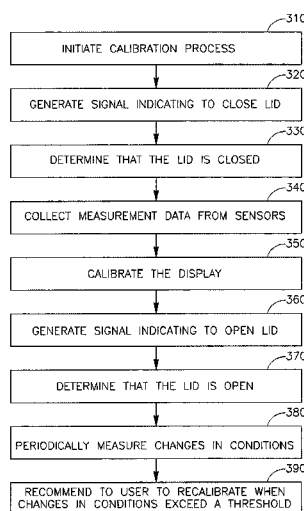
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(57) **ABSTRACT**

Device, system, and method for display calibration. For example, an apparatus includes: one or more color sensors, embedded within a body of a mobile device, to measure one or more color attributes of a visual element displayed by a display unit of the mobile device when a lid of the mobile device is in a closed position; and a color calibrator to calibrate one or more parameters of the display unit based on the one or more color attributes measured by the one or more color sensors.

22 Claims, 3 Drawing Sheets



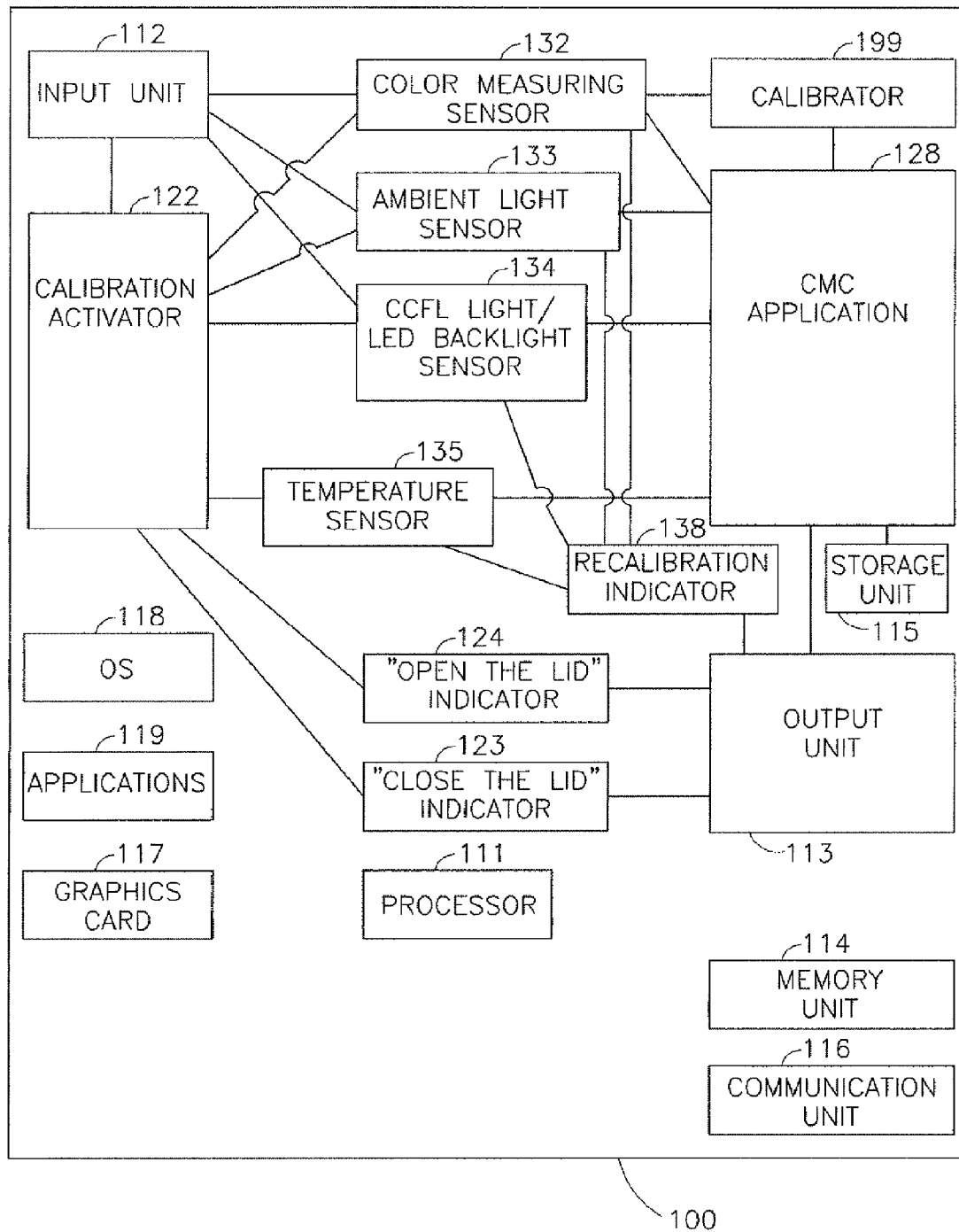


FIG. 1

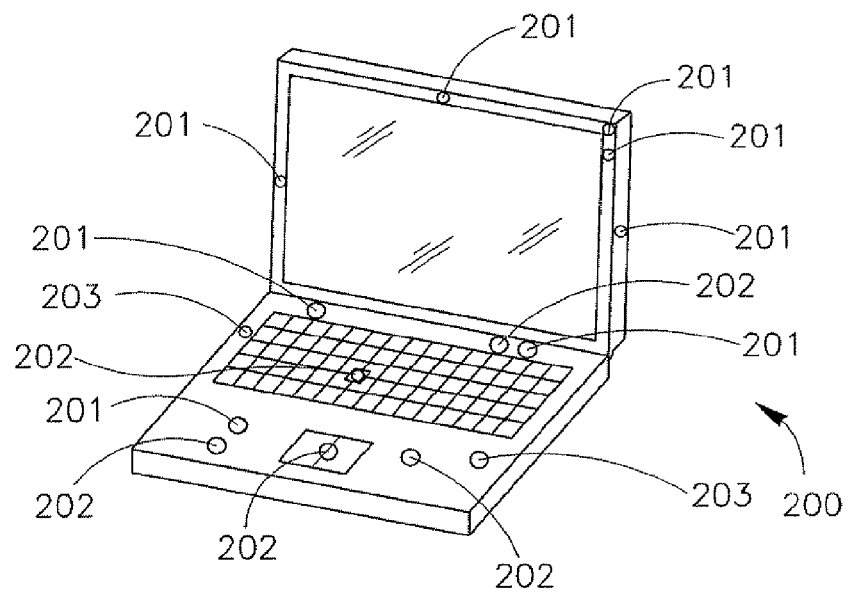


FIG. 2A

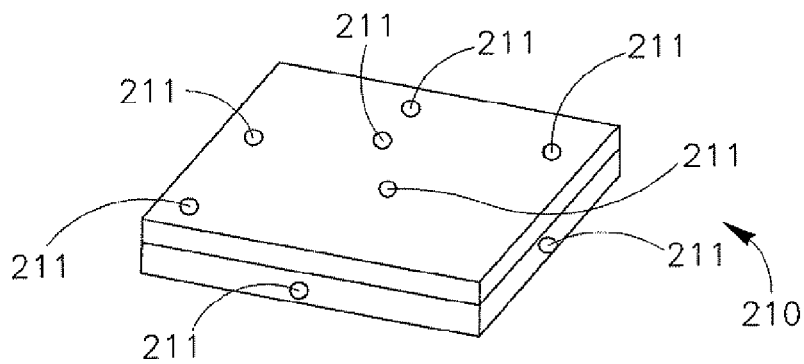


FIG. 2B

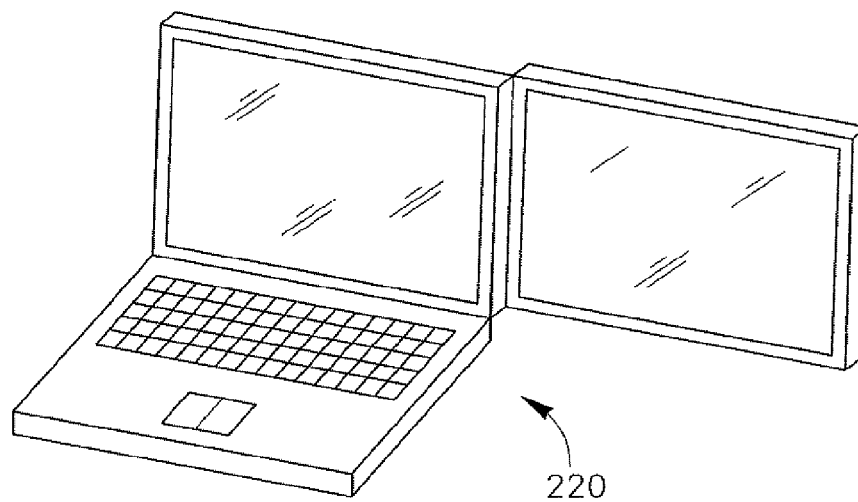
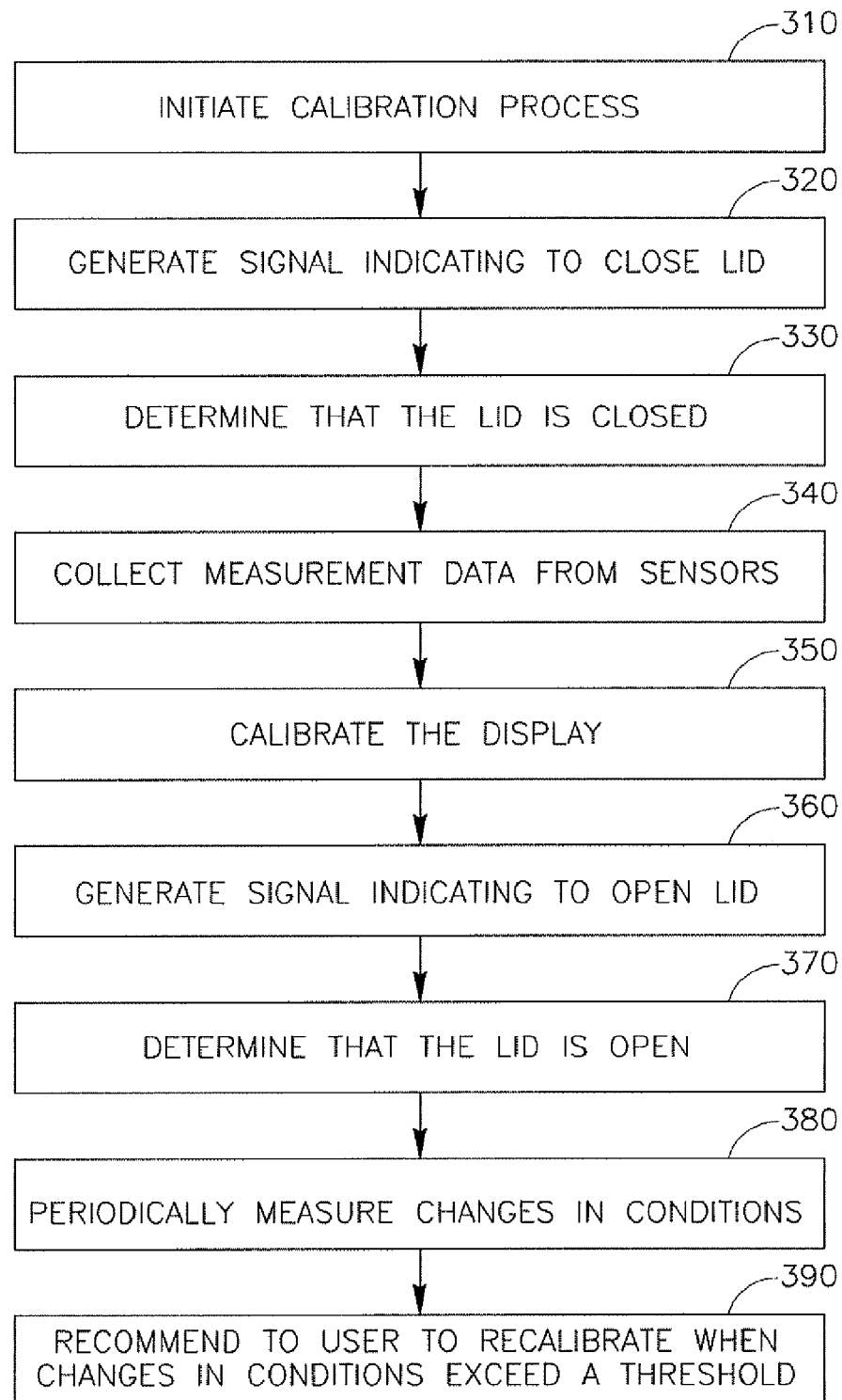


FIG. 2C

*FIG. 3*

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DEVICE, SYSTEM, AND METHOD OF DISPLAY CALIBRATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation claiming the benefit of, and priority to, previously filed U.S. patent application Ser. No. 11/964,024 filed Dec. 25, 2007, entitled "DEVICE, SYSTEM, AND METHOD OF DISPLAY CALIBRATION," the entirety of which is hereby incorporated by reference.

BACKGROUND

A computing system may include, for example, a screen or a monitor to display text and images processed or stored in the computing system. The screen may be able to display color visual elements, for example, colored images, photographs, video broadcasts, windows, or the like.

Unfortunately, the colors displayed on the screen may autonomously change during the operation of the computing system, or in the course of time. For example, the screen may display visual elements having incorrect colors (for example, pink instead of red).

BRIEF DESCRIPTION OF THE DRAWINGS

For simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity of presentation. Furthermore, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. The figures are listed below.

FIG. 1 is a schematic block diagram illustration of a system able to perform display calibration in accordance with a demonstrative embodiment of the invention.

FIGS. 2A-2C are schematic illustrations of a mobile computer in accordance with some demonstrative embodiments of the invention.

FIG. 3 is a schematic flow-chart of a method of display calibration in accordance with a demonstrative embodiment of the invention.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of some embodiments of the invention. However, it will be understood by persons of ordinary skill in the art that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, units and/or circuits have not been described in detail so as not to obscure the discussion.

Discussions herein utilizing terms such as, for example, "processing," "computing," "calculating," "determining," "establishing," "analyzing," "checking", or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulate and/or transform data represented as physical (e.g., electronic) quantities within the computer's registers and/or memories into other data similarly represented as physical quantities within the computer's registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes.

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The terms "plurality" and "a plurality" as used herein includes, for example, "multiple" or "two or more". For example, "a plurality of items" includes two or more items.

Some embodiments of the invention may be used in conjunction with various devices and systems, for example, a Personal Computer (PC), a desktop computer, a mobile computer, a laptop computer, a notebook computer, a tablet computer, a server computer, a handheld computer, a handheld device, a Personal Digital Assistant (PDA) device, a handheld PDA device, an on-board device, an off-board device, a hybrid device, a vehicular device, a non-vehicular device, a mobile or portable device, a non-mobile or non-portable device, a wireless communication station, a wireless communication device, a wireless Access Point (AP), a wired or wireless router, a wired or wireless modem, a wired or wireless network, a Local Area Network (LAN), a Wireless LAN (WLAN), a Metropolitan Area Network (MAN), a Wireless MAN (WMAN), a Wide Area Network (WAN), a Wireless WAN (WWAN), a Personal Area Network (PAN), a Wireless PAN (WPAN), devices and/or networks operating in accordance with existing IEEE 802.11, 802.11a, 802.11b, 802.11g, 802.11n, 802.16, 802.16d, 802.16e, 802.16m standards and/or future versions and/or derivatives and/or Long Term Evolution (LTE) of the above standards, units and/or devices which are part of the above networks, one way and/or two-way radio communication systems, cellular radio-telephone communication systems, a cellular telephone, a wireless telephone, a Personal Communication Systems (PCS) device, a PDA device which incorporates a wireless communication device, a mobile or portable Global Positioning System (GPS) device, a device which incorporates a GPS receiver or transceiver or chip, a device which incorporates an RFID element or chip, a Multiple Input Multiple Output (MIMO) transceiver or device, a Single Input Multiple Output (SIMO) transceiver or device, a Multiple Input Single Output (MISO) transceiver or device, a device having one or more internal antennas and/or external antennas, a wired or wireless handheld device (e.g., BlackBerry, Palm Treo), a Wireless Application Protocol (WAP) device, or the like.

The terms "lid" or "cover" as used herein include, for example, the physical portion of a mobile computer or a laptop computer having or containing the display or display unit of the computer, or a portion or a "half" of a mobile computer or laptop computer having or containing the display or display unit. The term "lids" or "covers" as used herein includes, for example, multiple lid units or cover units, for example, of a mobile or laptop computer having multiple displays.

FIG. 1 schematically illustrates a block diagram of a system **100** able to perform display calibration in accordance with some demonstrative embodiments of the invention. System **100** may be or may include, for example, a computing device, a computer, a Personal Computer (PC), a server computer, a client/server system, a mobile computer, a portable computer, a laptop computer, a multi-display laptop computer, a multi-screen laptop computer, a notebook computer, a tablet computer, a network of multiple inter-connected devices, or the like.

System **100** includes, for example, a processor **111**, an input unit **112**, an output unit **113**, a memory unit **114**, a storage unit **115**, a communication unit **116**, and a graphics card **117**. System **100** may optionally include other suitable hardware components and/or software components.

Processor **111** includes, for example, a Central Processing Unit (CPU), a Digital Signal Processor (DSP), one or more processor cores, a single-core processor, a dual-core processor, a multiple-core processor, a microprocessor, a host pro-

cessor, a controller, a plurality of processors or controllers, a chip, a microchip, one or more circuits, circuitry, a logic unit, an Integrated Circuit (IC), an Application-Specific IC (ASIC), or any other suitable multi-purpose or specific processor or controller. Processor **111** executes instructions, for example, of an Operating System (OS) **118** of system **100** or of one or more applications **119**.

Input unit **112** includes, for example, a keyboard, a keypad, a mouse, a touch-pad, a track-ball, a stylus, a microphone, or other suitable pointing device or input device. Output unit **113** includes, for example, a monitor, a screen, a Cathode Ray Tube (CRT) display unit, a Liquid Crystal Display (LCD) display unit, a Light Emitting Diode (LED) display unit, an Organic LED (OLED) display unit, a plasma display unit, one or more audio speakers or earphones, or other suitable output devices. Graphics card **117** includes, for example, a graphics or video processor, adapter, controller or accelerator.

Memory unit **114** includes, for example, a Random Access Memory (RAM), a Read Only Memory (ROM), a Dynamic RAM (DRAM), a Synchronous DRAM (SD-RAM), a flash memory, a volatile memory, a non-volatile memory, a cache memory, a buffer, a short term memory unit, a long term memory unit, or other suitable memory units. Storage unit **115** includes, for example, a hard disk drive, a floppy disk drive, a Compact Disk (CD) drive, a CD-ROM drive, a Digital Versatile Disk (DVD) drive, or other suitable Removable or non-Removable storage units. Memory unit **114** and/or storage unit **115**, for example, store data processed by system **100**.

Communication unit **116** includes, for example, a wired or wireless Network Interface Card (NIC), a wired or wireless modem, a wired or wireless receiver and/or transmitter, a wired or wireless transmitter-receiver and/or transceiver, a Radio Frequency (RF) transceiver or communication unit, or other units able to transmit and/or receive signals, blocks, frames, transmission streams, packets, messages and/or data. Communication unit **116** optionally includes, or is optionally associated with, one or more antennas, for example, a dipole antenna, a monopole antenna, an omni-directional antenna, an end fed antenna, a circularly polarized antenna, a micro-strip antenna, a diversity antenna, or the like.

In some embodiments, components of system **100** may be enclosed in a common housing or packaging, and may be interconnected or operably associated using one or more wired or wireless links. In other embodiments, components of system **100** may be distributed among multiple or separate devices or locations, may be implemented using a client/server configuration or system, or may communicate using remote access methods.

In some embodiments, system **100** is implemented as a laptop computer, having a lid portion and a base portion, interconnected through a common axis or pivot that allows opening and closing of the laptop computer, e.g., similar to opening and closing of a book. The lid portion or its body includes a display unit embedded therein, which may be calibrated in accordance with some embodiments of the invention.

System **100** may additionally include a calibration activator **122**, able to initiate or activate the calibration process. In some embodiments, calibration activator **122** may be, for example, a button, a mouse button, a keyboard key, a stand-alone application, an application or program which is part of OS **118**, a driver, or the like. In some embodiments, for example, when system **100** is implemented as a mobile or a laptop computer, calibration activator **122** may activate an application, temporarily overriding pre-programmed functions associated with a closing switch of the lid. Accordingly,

calibration activator **122** may initiate the maintaining of the display(s) active, even while the lid of the mobile computer or laptop computer is being closed or is hermetically closed.

In some embodiments, calibration activator **122** may be connected to and/or activate one or more sensors, for example, one or more Color Measuring (CM) sensors **132**, one or more Ambient Light (AL) sensors **133**, one or more Cold-Cathode-Fluorescent-Lamp (CCFL) light or LED backlight sensors **134**, and/or one or more temperature sensors **135**. Sensors **132-135** may be located in different portions of system **100**, for example, as detailed herein with reference to FIGS. 2A-2C. In some embodiments, sensors **132-135** may be embedded within the body or housing of system **100**, for example, in the lid of the mobile computer, in the frame surrounding the display of the mobile computer, on the back or side of the lid of the mobile computer.

The one or more CM sensor(s) **132** is/are able to scan the display and measure multiple attributes thereof, for example: color, contrast, brightness, hue, saturation, or other attributes. The AL sensor **133** is able to measure multiple attributes of ambient light, for example: strength, brightness, color, shade, direction, or the like. The sensor **134** is able to measure and/or monitor CCFL light or LED backlight, for example, of a LCD unit. The temperature sensor **135** is able to measure the temperature in the surrounding of the display of system **100**.

In some embodiments, for example, in which system **100** is implemented as a mobile or laptop computer, calibration activator **122** may activate a "close the lid(s)" indicator **123**. "Close the lid" indicator **123** may include, for example, a message displayed on the display(s), an audible signal, a blinking signal, or the like. "Close the lid" indicator **123** may alert the user to close the display(s), for system **100** to perform the calibration process.

In some embodiments, for example, in which system **100** is implemented as a mobile or laptop computer, CM sensor(s) **132** may be located in one or more suitable locations on the top surface of the keyboard portion. This may allow, for example, for CM sensor **132** to face the display, or at least a portion thereof, when the lid is closed.

In some embodiments, for example, after CM **132** is activated by calibration activator **122** and the lid is closed, the display remains active. A Color and Management Calibration (CMC) application **128** activates a visual element, causing the image to be displayed on the display or on a portion thereof, for example, on the portion of the display faced by CM sensor **132**. The visual element includes, for example, graphical signals or images, representing the display image at the time of calibration. The CM sensor **132** automatically scans the visual element, and measures the attributes thereof.

In some embodiments, system **100** may be a mobile computer including two displays, namely, a first display and a second display. Accordingly, a first CM sensor **132** or a first set of CM sensors **132** may be located to face the first display when the first lid is closed; and a second CM sensor **132** or a second set of CM sensors **132** may be located to face the second display when the second lid is closed. During calibration, when both lids are closed, the first CM sensor **132** or set of CM sensors **132** scan a first visual element, generated by the first display; whereas the second CM sensor **132** or set of CM sensors **132** scan a second visual element, generated by the second display. The first and second displays may then be calibrated based on the data measured by the first and second CM sensors **132**, or sets of CM sensors **132**, respectively.

In some embodiments, calibration activator **122** may additionally activate one or more AL sensors **133**. In some embodiments, in which system **100** is a mobile computer or a laptop computer, one or more AL sensors **133** may be located

on the top or outer surface of the display portion. In other embodiments, one or more AL sensors **133** may be located in other suitable places, for example, along the sides of the keyboard portion, along the sides of the display portion, or in other suitable locations. In some embodiments, during the calibration process, while the lid(s) is/are closed and CM sensors **132** scan the display(s), the one or more AL sensors **133** may face the surrounding of the computer, automatically measuring the ambient light and attributes thereof, surrounding the display(s). In some embodiments, for example, in which system **100** is a mobile computer or a laptop computer including two displays, AL sensors **133** may be located on both displays or in the vicinity thereof. This may allow, for example, measurement of different or multiple ambient lights surrounding each display, thereby allowing to calibrate each display separately or independently, taking into account the possibly different multiple ambient lights. The ambient light measurement, as measured by AL sensors **133**, is stored and brought into account during the calibration process. This may allow to calibrate the display(s) to show an image, generally matching the image shown in output devices, to which the image is transferred. For example, photographs, magazine papers, HDTV broadcasts, or the like.

In some embodiments, calibration activator **122** may additionally activate one or more CCFL light or LED backlight sensors **134**. For example, if system **100** includes a LCD unit, sensor **134** may measure the CCFL light and/or the LED backlight of the LCD, while sensors **132** and **133** are active. The sensors **134** may be located in any suitable portion of system **100** to measure the CCFL light and/or the LED backlight of the LCD.

In some embodiments, calibration activator **122** may additionally activate a temperature sensor **135**. For example, in which system **100** is a mobile or a laptop computer, temperature sensor **135** may be located in any suitable portion of the computer, measuring the temperature of the surrounding air.

The temperature measured by the temperature sensor **135**, as well as changes thereof, may be substantially continuously monitored, and may be taken into account, for example, in order to determine recalibration, and/or as part of the calibration process.

In some embodiments, for example, in which system **100** is a mobile or a laptop computer, once the sensors **132-135** complete the measuring process, a signal, for example, an audible signal or a visual signal generated by an "open the lid" indicator **124**, may alert the user that the multiple measurements are completed. In some embodiments, for example, in which system **100** is a mobile or a laptop computer including two displays, CM sensors **132** may automatically perform measurements separately, or independently on each display.

In some embodiments, the data received from the sensors **132-135** may be stored, for example in memory unit **114**, and may be processed using the CMC application **128**. CMC application **128** may receive the data from the sensors **132-135**, and may perform a calibration process, for example, using processor **111**. In some embodiments, after the calibration process is complete, the calibrated image is displayed on the display(s), that is/are part of, for example, output unit **113**. In some embodiments, for example, in which system **100** is a mobile or a laptop computer, once the calibration process is complete, a user that operates system **100** may open the lid(s) and see the calibrated image on the display(s). In some embodiments, CMC application **128** may calibrate the display(s), such that the image seen in the calibrated display(s) generally corresponds to the image seen in output devices, for example: photographs, magazine papers, HDTV broadcasts, or the like.

In some embodiments, system **100** may include a recalibration indicator **138**. In some embodiments, recalibration indicator **138** may be connected to or associated with one or more of sensors **133-135**, and may initiate sensors **133-135** to perform the herein-described measurements, periodically or substantially continuously. The recalibration indicator **138** may store the data received from the sensors **133-135**. In some embodiments, recalibration indicator **138** may retrieve the stored data in order to process the data, and may detect a change in conditions (for example, a change of ambient light, temperature, CCFL light and/or LED backlight) measured by sensors **133-135**. The RI **138** may calculate and determine whether or not the change in conditions exceeds a pre-defined threshold. For example, in case the change in conditions exceeds the pre-defined threshold, an audible signal or a message shown on the display may be generated, recommending the user to perform a recalibration of the display, and allowing the user to respond to the recommendation by selecting to recalibrate the display.

In some embodiments, for example, in which system **100** is a mobile or laptop computer, a user that operates system **100** may calibrate the display(s) by pressing calibration activator **122**, closing the computer lid(s), waiting for a signal, and re-opening the lid(s), substantially without additional operations required on the behalf of the user.

In some embodiments, the system may allow calibrating the display, based on multiple pre-defined International Color Consortium (ICC) profiles or based on Pantone Matching Systems colors or other color schemes or standards. For example, a user that operates the system **100** may pre-define the calibration settings to result in displaying images having characteristics of a DVD video, a magazine sheet, a photograph, or the like.

In some embodiments, for example, in which system **100** includes an OLED display, the recalibration indicator **138** may notify the user that a recalibration is recommended, for example, to compensate for one or more fading blue pixels which may be associated with some OLED displays.

In some embodiments, for example, initial calibration activated by calibration activator **122** and/or other calibration(s) activated by recalibration indicator **138**, may allow performing the calibration without the need to wait for the display to warm up, e.g., at all or for a long time.

Although portions of the discussion herein relate, for demonstrative purposes, to multiple sensors and/or to multiple locations of sensors, embodiments of the invention are not limited in this regard. For example, some embodiments may include or may utilize a single sensor or a single color sensor, optionally implemented using a set of multiple sub-sensors; some embodiments may include or may utilize a single sensor able to perform the functions of multiple sensors described herein; some embodiments may include or may utilize a set of sensors or sub-sensors, co-located or spatially separated or distanced, able to perform the functions of multiple sensors described herein; some embodiments may utilize a single-location sensor, a single-location set of sensors, a multiple-location sensor, or a multiple-location set of sensors; or the like. In some embodiments, calibration operations may be based on measurement(s) performed by a single sensor, by multiple sensors, by a set of sensors, by a sensor implemented using multiple sub-sensors, or the like.

FIG. 2A schematically illustrates a mobile computer in accordance with some demonstrative embodiments of the invention. FIG. 2A schematically illustrates a three-dimensional perspective of a mobile computer **200**, with an open lid.

In some embodiments, mobile computer **200** may include multiple locations **201** suitable for including sensors for mea-

asuring ambient light, for example, AL sensors **133** of system **100**. Locations **201** may be located, for example, along the side surface of the keyboard portion, above or below the display in the display portion, above or below the keyboard in the keyboard portion, included in the keyboard, included in the touchpad or in other suitable locations. Other suitable locations may be used.

In some embodiments, mobile computer **200** may include multiple locations **202** suitable for including sensors for measuring color, for example, CM sensors **132** of system **100**. Locations **202** may be located, for example, above, below or besides the keyboard in the keyboard portion, in the touchpad, in the keyboard, or in other suitable locations. Other suitable locations may be used.

In some embodiments, mobile computer **200** may include multiple locations **203** suitable for including sensors for measuring temperature, for example, TM sensors **135** of system **100**. Locations **203** may be located, for example, above, below or besides the keyboard in the keyboard portion, in the touchpad, in the keyboard, or in other suitable locations.

FIG. 2B schematically illustrates a mobile computer in accordance with some demonstrative embodiments of the invention. FIG. 2B schematically illustrates a three-dimensional perspective of a mobile computer **210**, with a closed lid.

In some embodiments, mobile computer **210** may include multiple locations **211**, suitable for including sensors for ambient light measuring, for example, AL sensors **133** of system **100**. Locations **211** may be located for example, on the top or outer surface of the display portion, in the general middle area of the display portion, the general corners area of the display portion the general middle/top and/or middle/bottom area of the display portion, or in other suitable locations.

In some embodiments, the CMC application **128** may be implemented as a software component, a program, a driver, a device driver, a driver of a display unit, a driver of a graphics card, an OS component, and/or a hardware component. In some embodiments, the CMC application **128** may be associated with, or may include, or may be implemented using, a calibrator **199**, for example, a calibrator component or calibrator module. The calibrator **199** may perform the calibration of the output unit **113**, for example, by modifying a signal that system **100** generates to the output unit **113**. The modification is based on the measurements performed by sensors **132-135**, and/or based on the calculations performed by the CMC application **128**.

FIG. 2C schematically illustrates a mobile computer in accordance with some demonstrative embodiments of the invention. FIG. 2C schematically illustrates a three-dimensional perspective of a mobile computer **220** with two displays, in which the display lids are open.

In some embodiments, mobile computer **220**, may include sensors, for example sensors **132-135**, suitable for performing the above-mentioned measurements for calibrating the first display, and/or identical or similar, additional sensors **132-135**, suitable for performing the above-mentioned measurements for calibrating the second display, e.g., independently, in parallel, in series, or the like.

FIG. 3 is a schematic flow-chart of a method of display(s) calibrating in accordance with some demonstrative embodiments of the invention. Operations of the method may be used, for example, by system **100** of FIG. 1, by system **200** of FIG. 2A, by system **210** of FIG. 2B, by system **220** of FIG. 2C, and/or by other suitable units, devices and/or systems.

In some embodiments, the method may include, for example, initiating the calibration process (block **310**), for

example, in response to a user pressing a calibration button or activating a calibration application, as described above.

In some embodiments, the method may include, for example, generating a signal, indicating to close the lid(s) (block **320**). The signal may include an audible signal, a visual signal, a message on the display, or the like.

In some embodiments, the method may include, for example, determining that the lid or lids is/are closed (block **330**). This may be done performed, for example, using methods or mechanisms similar to those used for sensing the closure of a lid in a mobile computer.

In some embodiments, the method may include, for example, collecting measured data from sensors (block **340**), for example, sensors **132-135** of system **100**, e.g., CM sensor **132**, AL sensor **133**, temperature sensor **135**, and/or the CCFL light/LED backlight sensor **134**. This may include, for example, initiating the sensors **132-135** to start sensing and/or measuring. The initiating may be performed, for example, by calibration activator **122** of system **100**, or by CMC application **128** of system **100**. The collecting may additionally include, for example, waiting a pre-defined time for the sensors to perform the measurement, and storing the measured data, for example in storage unit **115** of system **100**, for the calibration process to initiate.

In some embodiments, the method may include, for example, calibrating the display(s) of the laptop (block **350**). The calibration of the display(s) may be performed, for example, based on data received from sensors **132-135**, and stored in storage unit **115**, as described above. The calibration may include taking into account the external conditions (e.g., ambient light) and internal conditions (e.g., the current color of the display, and CCFL light). In some embodiments, the calibration may yield a displayed image generally identical to the same image displayed in output devices, for example, printed photographs, HDTV broadcasting, or the like.

In some embodiments, the method may include, for example, generating a signal, indicating to open the lid(s) (block **360**), upon finishing the calibration. The signal may include, for example, an audible signal or a visual signal, for example, a blinking light generated by a small light bulb located, for example, on the outer surface of the lid portion.

In some embodiments, the method may include, for example, determining that the lid or lids are opened (block **370**), for example, using the method or mechanism of block **330**.

After the calibration process is complete, in some embodiments, the method may include, for example, periodically, or substantially continuously, measuring conditions and condition changes (block **380**). For example, the method may include performing the above-mentioned measurements using sensors **133-135** of system **100**. As described, the data received from the sensors may be stored and processed.

In some embodiments, for example, if the changes in conditions exceed a pre-defined threshold, the method may include recommending to a user to recalibrate the display(s) (block **390**). The recommending may be performed, for example, by generating a message on the display(s), an audible signal, a warning signal or the like. For example, a user that operates the computer may select to accept the recommendation, and may command to initiate a recalibration, resulting in a process using the method described herein. This may be performed, for example, when a previous calibration requires updating.

Other suitable operations or sets of operations may be used in accordance with embodiments of the invention.

Some embodiments of the invention, for example, may take the form of an entirely hardware embodiment, an entirely

software embodiment, or an embodiment including both hardware and software elements. Some embodiments may be implemented in software, which includes but is not limited to firmware, resident software, microcode, or the like.

Furthermore, some embodiments of the invention may take the form of a computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any instruction execution system. For example, a computer-usable or computer-readable medium may be or may include any apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

In some embodiments, the medium may be an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. Some demonstrative examples of a computer-readable medium may include a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk, and an optical disk. Some demonstrative examples of optical disks include compact disk-read only memory (CD-ROM), compact disk-read/write (CD-R/W), and DVD.

In some embodiments, a data processing system suitable for storing and/or executing program code may include at least one processor coupled directly or indirectly to memory elements, for example, through a system bus. The memory elements may include, for example, local memory employed during actual execution of the program code, bulk storage, and cache memories which may provide temporary storage of at least some program code in order to reduce the number of times code must be retrieved from bulk storage during execution.

In some embodiments, input/output or I/O devices (including but not limited to keyboards, displays, pointing devices, etc.) may be coupled to the system either directly or through intervening I/O controllers. In some embodiments, network adapters may be coupled to the system to enable the data processing system to become coupled to other data processing systems or remote printers or storage devices, for example, through intervening private or public networks. In some embodiments, modems, cable modems and Ethernet cards are demonstrative examples of types of network adapters. Other suitable components may be used.

Functions, operations, components and/or features described herein with reference to one or more embodiments, may be combined with, or may be utilized in combination with, one or more other functions, operations, components and/or features described herein with reference to one or more other embodiments, or vice versa.

While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents may occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes.

What is claimed is:

1. An apparatus comprising:

one or more color sensors, embedded within a body of a computing device, to measure one or more color attributes of a visual element displayed by a display unit of the computing device; and

color calibrator logic to:

calibrate one or more parameters of the display unit based on at least the one or more color attributes measured by the one or more color sensors when the

lid is in the closed position and based on detected ambient light surrounding the computing device when the lid is in the closed position;

allow the display unit of the computing device to remain operational upon closure of the lid at least when the one or more color sensors measure the one or more color attributes;

repeatedly send a control signal to the one or more color sensors, the control signal to include an indication to measure the one or more color attributes when the lid is in the open position;

determine whether the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition; and

provide a notification to recalibrate the one or more parameters of the display based on the determination that the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition;

the one or more color sensors comprising multiple sensors including separate sensors to measure the color attributes and the ambient light.

2. The apparatus of claim 1, wherein the one or more color sensors to measure a grid of multiple colors displayed on the display unit.

3. The apparatus of claim 1, wherein the color calibrator logic:

to utilize at least one audible signal on the outside of the computing device to indicate a current calibration is in process or complete.

4. The apparatus of claim 1, wherein the color calibrator logic:

to utilize at least one visual signal on the outside of the computing device to indicate a current calibration is in process or complete.

5. The apparatus of claim 1, wherein at least one of the one or more color sensors is located adjacent to a bottom row of keys on a keyboard of the computing device.

6. The apparatus of claim 1, further comprising: one or more ambient light sensors embedded within the body of the computing device, wherein the color calibrator logic to at least determine whether the lid of the computing device is closed from information retrieved from the one or more ambient light sensors.

7. An apparatus comprising:

color calibrator logic to:

calibrate one or more parameters of a display unit of a computing device based on at least one or more measured color attributes of a visual element displayed by the display unit and based on detected ambient light surrounding the computing device when a lid of the computing device is in a closed position, wherein the color attributes are measured by one or more color sensors embedded within a body of the computing device, the one or more color sensors comprising multiple sensors including separate sensors to measure the color attributes and the ambient light;

allow the display unit of the computing device to remain operational upon closure of the lid at least when the one or more color sensors measure the one or more color attributes;

repeatedly send a control signal to the one or more color sensors, the control signal to include an indication to measure the one or more color attributes when the lid is in the open position;

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determine whether the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition; and

provide a notification to recalibrate the one or more parameters of the display based on the determination that the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition.

8. The apparatus of claim 7, wherein the one or more color sensors to measure a grid of multiple colors displayed on the display unit.

9. The apparatus of claim 7, wherein the color calibrator logic:

to utilize at least one audible signal on the outside of the computing device to indicate a current calibration is in process or complete.

10. The apparatus of claim 7, wherein the color calibrator logic:

to utilize at least one visual signal on the outside of the computing device to indicate a current calibration is in process or complete.

11. The apparatus of claim 7, wherein at least one of the one or more color sensors is located adjacent to a bottom row of keys on a keyboard of the computing device.

12. The apparatus of claim 7, further comprising:

one or more ambient light sensors embedded within the body of the computing device, wherein the color calibrator logic to at least determine whether the lid of the computing device is closed from information retrieved from the one or more ambient light sensors.

13. A method comprising:

calibrating one or more parameters of the display unit of a computing device based on at least one or more measured color attributes of a visual element displayed by the display unit and based on detected ambient light surrounding the computing device when a lid of the computing device is in a closed position, wherein the color attributes are measured by one or more color sensors embedded within a body of the computing device, the one or more sensors comprising multiple sensors including separate sensors to measure the color attributes and the ambient light;

allowing the display unit of the computing device to remain operational upon closure of the lid at least when the one or more color sensors measure the one or more color attributes;

repeatedly send a control signal to the one or more color sensors, the control signal to include an indication to measure the one or more color attributes when the lid is in the open position;

determine whether the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition; and

provide a notification to recalibrate the one or more parameters of the display based on the determination that the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition.

14. The method of claim 13, further comprising: measuring a grid of multiple colors displayed on the display unit.

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15. The method of claim 13, further comprising:

utilizing at least one audible signal on the outside of the computing device to indicate a current calibration is in process or complete.

16. The method of claim 13, wherein the color calibrator logic:

utilizing at least one visual signal on the outside of the computing device to indicate a current calibration is in process or complete.

17. The method of claim 13, further comprising:

determining whether the lid of the computing device is closed from information retrieved from one or more ambient light sensors embedded within the body of the computing device.

18. A non-transient computer readable medium having stored thereon instructions, the instructions, when executed by a computer cause the computer to:

calibrate one or more parameters of the display unit of a computing device based on at least one or more measured color attributes of a visual element displayed by the display unit and based on detected ambient light surrounding the computing device when a lid of the computing device is in a closed position, wherein the color attributes are measured by one or more color sensors embedded within a body of the computing device, the one or more sensors comprising multiple sensors including separate sensors to measure the color attributes and the ambient light;

allow the display unit of the computing device to remain operational upon closure of the lid at least when the one or more color sensors measure the one or more color attributes;

repeatedly send a control signal to the one or more color sensors, the control signal to include an indication to measure the one or more color attributes when the lid is in the open position;

determine whether the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition; and

provide a notification to recalibrate the one or more parameters of the display based on the determination that the one or more color attributes measured by the one or more color sensors when the lid is in the open position deviate from a threshold condition.

19. The non-transient computer readable medium of claim 18, further comprising:

measure a grid of multiple colors displayed on the display unit.

20. The non-transient computer readable medium of claim 18, further comprising:

utilize at least one audible signal on the outside of the computing device to indicate a current calibration is in process or complete.

21. The non-transient computer readable medium of claim 18, wherein the color calibrator logic:

utilize at least one visual signal on the outside of the computing device to indicate a current calibration is in process or complete.

22. The non-transient computer readable medium of claim 18, further comprising:

determine whether the lid of the computing device is closed from information retrieved from one or more ambient light sensors embedded within the body of the computing device.